

**Mindfulness and Mind-Wandering in Older Adults:
Implications for Behavioral Performance**

Research Thesis

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by

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Abstract

Mind-wandering is defined as an attentional shift from the task at hand to internally generated thoughts. Although common, mind-wandering is associated with decreased performance on tasks requiring sustained attention and executive control. In juxtaposition to mind-wandering, mindfulness is characterized by attending nonjudgmentally to the present moment. Recent studies of both mindfulness disposition and mindfulness training provide evidence for associations between higher levels of mindfulness, decreased mind-wandering and improved cognitive performance. Interestingly, researchers have found that our tendency to mind wander decreases with age where as mindfulness disposition increases with age. The goal of the current study was to further examine the association between mindfulness and mind-wandering in an ageing population. Seventy-four older adults (ages 60-74) completed measures of dispositional mindfulness and mind-wandering as well as two computerized tasks: the Go/No-Go task and the word version of the Continuous Performance Task (CPT-WORD). Extending previous findings to an older adult sample, dispositional mindfulness was negatively associated with mind-wandering on both tasks. Surprisingly, mind-wandering was not significantly associated with behavioral performance on either of the tasks. Contrary to our hypotheses, dispositional mindfulness was not significantly associated with accuracy on the Go/No-Go task. Interestingly, mindfulness was positively associated with reactive, but not proactive, control on the CPT-WORD. Our results suggest that the relationship between mindfulness and mind-wandering exists in an older adult sample; however, the relationship between these two constructs and indices of cognitive control is mixed across varying tasks.

Introduction

Aging and Cognitive Control

According to the 2013 Census survey, nearly 44.7 million people in the United States are over the age of 65, accounting for 14.1 percent of the total population (U.S. Census Bureau, 2014, p. 201). This number is only expected to get higher with a projected 88.5 million individuals 65 and older in 2050. If this projection is realized, individuals in this age group will comprise 20 percent of the total population. With this demographic shift, there are increasing expectations for older adults to continue to be contributing members of society, in their professional and personal lives. The percentage of people between ages 65 and 69 who are working grew 9 percentage points to 30.8 percent in 2010 (U.S. Census Bureau, 2010). These numbers are expected to further increase as baby boomers continue to reach retirement age. A 2013 Conference Board survey found that 62 percent of people ages 45 to 60 plan to delay retirement, up from 42 percent in 2010 (U.S. Census Bureau, 2012).

Amid these high demands, the natural aging process continues. As we age, our brains undergo remarkable structural and functional alterations that impact every aspect of our day-to-day life. Declines in cognition occur in many domains, including cognitive control (Craig & Salthouse, 2008). Such regulatory processes involve systematic means of adjusting psychophysiological functioning according to external or internal directives. This type of control is involved in any type of goal-directed behavior, including many of our daily activities and is essential to the way we react to the world around us. Additionally, performance in other cognitive capacities such as processing speed, working memory, attention, and executive function are compromised as age increases (Braver & West, 2008; Craig & Salthouse, 2008; Lindenberger et al., 2008; McDowd & Fillion, 1992; Park et al., 2002; Park & Reuter-Lorenz,

2009; Salthouse, 2010; Verhaeghen & Cerella, 2008). However, it is important to note that these changes are accompanied by cortical reorganization and compensation (Reuter-Lorenz & Lustig, 2005). This evidence of a plastic brain, even as we age, holds promise for a more optimistic view of neurocognitive function later in life.

The Dual Mechanisms of Control (DMC) model provides a conceptualization of the neural dynamics of cognitive control. This theory may be capable of integrating findings regarding the age-related shifts in cognitive function (Braver, Gray, & Burgess, 2007) by providing a nuanced view of age-related variation in cognitive control. It suggests that instead of global declines in controlled processing, older adults experience a shift in the type of control strategies they engage in. One application of the DMC model frames differences based on age in terms of two separate attentional strategies: proactive and reactive control. Proactive control involves maintaining task goals across trials to enhance early selection and response to task-appropriate stimuli (Miller & Cohen, 2001). Behaviorally, proactive control manifests as efficient performance, including fast reaction times and highly accurate performance. By contrast, reactive control involves the reactivation of task goals upon presentation of a target stimulus (Jacoby, Kelley, & McElree, 1999). It is reflected by high accuracy but slower reaction times, which are indicative of “last moment” recruitment of control.

Proactive and reactive control can be examined using the Continuous Performance Task (CPT), which requires maintenance of task goals in the context of both probes and cues. In this task, participants are presented with cue-probe pairs and instructed to make a target response to the X-probe, but only when it follows an A-cue (“AX” or target sequence). On all other trials, non-target responses are required. These would include “AY”, “BX” and “BY” sequences, where “B” and “Y” are simply non-“A” or non-“X” respectively. Based on this design, proactive and

reactive controls are measured through examining the utilization of contextual cues to update task goals. First, “AY” trials involve activating proactive control that allows us to examine the tendency to make false alarms when the target A-cue is followed by a nontarget probe (“Y” instead of “X”). Secondly, “BX” trials involve reactive control, which leads to a tendency to make a prepotent response when an X-probe follows a non-A-cue (“B” instead of “A”).

Interestingly, aging appears to be associated with a shift away from proactive control toward the less efficient reactive mode of processing (Braver, 2012; Braver & Barch, 2002). Older adults’ impaired ability to actively maintain representations of context, corresponding with an increased susceptibility to intrusive goal-irrelevant information, ultimately leads to more incorrect responses (Leon & Abando, 2013). Interestingly, their ability to engage in reactive control is both flexible and retained (Bugg, 2014). This further underscores the fact that aging is not associated with general deficits in cognitive control and that a more nuanced approach is needed to uncover this complex process.

Mind Wandering: Phenomenology and Current Theories

Whether it’s working on a new project for an employer, enjoying a newspaper article, or listening to new prescription information from a physician, our attention is often required to be sustained over a period of time. Interestingly, difficulty in maintaining attentional focus may lead to a tendency to disengage from the task at hand, especially over the sustained periods needed in most everyday undertakings. This disengagement is defined as mind-wandering, a phenomenon that recent research suggests has an important bearing on cognitive control (Randall, Oswald, & Beier, 2014). Mind-wandering has been operationalized as “a shift of executive control away from a primary task to the processing of personal goals” (Smallwood & Schooler, 2006, p. 946). The default-mode network, which includes the medial temporal lobe, part of the medial

prefrontal cortex, and the posterior cingulate cortex, is implicated in self-referential thinking and attention to internal thoughts (Buckner, Andrews-Hanna, & Schacter, 2008; Greicius, Krasnow, Reiss, & Menon, 2003), has been found to be active during mind-wandering episodes (Christoff, Gordon, Smallwood, Smith, & Schooler, 2009). Mind-wandering is pervasive in that disengagement from primary tasks happens frequently and there is evidence that this frequency is maintained across a variety of activities. For example, one experience sampling study found that mind-wandering occurred in 46.9% of randomly timed questions. The nature of the activity interrupted by the probe had only a modest impact on whether participants' minds wandered, and it had almost no impact on the pleasantness of the topics to which their minds wandered (Killingsworth & Gilbert, 2010).

Mind-wandering indeed serves some functional purposes. Spontaneous thought can be adaptive, especially when solving complex problems (Baars, 2010). One study found that the facilitation of mind-wandering by performing simple tasks has been linked to improved performance on tasks that require creativity (Baird et al., 2012). In some circumstances, being disengaged from the current task can be advantageous, particularly when that task involves the consideration of long-term goals. One study found that participants were more likely to wait for a monetary reward when they spent more time mind-wandering during a minimally engaging task (Smallwood, Ruby, & Singer, 2013). However, many negative functional ramifications of mind-wandering have been demonstrated, specifically when performing tasks that require focused attention (Mooneyham & Schooler, 2013). The degree to which we are able to sustain attention significantly impacts our ability to function successfully in class, the workplace or simply in everyday life. Behaviorally, mind-wandering is characterized by rapid and "automatic" responses during tasks that require sustained attention (Smallwood et al., 2004). This behavior is associated

with decreased performance on a variety of laboratory and everyday tasks, including necessities like reading comprehension (Giambra & Grodsky, 1989; Jackson & Balota, 2012; Mrazek, Phillips, Franklin, Broadway, & Schooler, 2013).

The majority of evidence suggests that mind-wandering is detrimental to performance on a primary cognitive task (Helton, Kern, & Walker, 2009; Helton & Warm, 2008; McVay & Kane, 2012a; Mrazek, Smallwood, & Schooler, 2012; Smallwood, Baracaia, Lowe, & Obonsawin, 2003). This may be due in part to differential levels of external processing involved in mind-wandering and non-mind-wandering states. A recent EEG study found high levels of mind-wandering are associated with less cortical processing of external events and a shift in focus toward internal thoughts, which happens regardless of the relevance of these thoughts to the task (Barron, Riby, Greer, & Smallwood, 2011).

Still, the relationship between mind-wandering and performance is not direct across varying tasks. For example, low demand tasks allow enough resources for the mind to wander, and for task performance to remain unaffected (Teasdale, Proctor, Lloyd, & Baddeley, 1993), whereas high demand tasks tend to require more cognitive resources, and thus less resources are available to mind-wander. Theoretically, in a medium demand task, competition for allocating resources to either the task or mind-wandering would be the greatest and behavioral performance on these task may reflect these competing processes. All of these task-related factors would interact with an individual's engagement with the task, the salience of mind-wandering, practice effects as well as fatigue (Smallwood & Schooler, 2006). Thus, understanding both the cognitive and neural underpinnings of this process is vital given the impact of mind-wandering on important cognitive functions.

Currently, there is controversy in the theoretical explanation of the process and cause of mind-wandering. Smallwood (2013) recently differentiated the mind-wandering experience into two key aspects: a) how the mind wanders, which entails the process of maintaining the continuity of a mind-wandering episode; and b) why the mind wanders, which refers to those mechanisms that lead to the occurrence of a mind-wandering episode. Currently, there are two competing hypotheses postulating the underlying processes of mind-wandering: the decoupling hypothesis and the “control failures x current concerns” hypothesis.

The decoupling hypothesis (Smallwood & Schooler, 2006) explains mind-wandering as a process in which attention becomes coupled to an internal process and decoupled from an external process. Processes such as executive control and resource allocation do not directly control the occurrence of self-generated thought but instead are engaged once this information becomes the target of attention (Smallwood, Brown, Baird, & Schooler, 2012). In the decoupling hypothesis, mind-wandering is construed as a non-spontaneous, effortful process requiring attentional resources to support internal thoughts. Maintenance of off-task thought is assumed to require attentional resources. Thus, resource allocation is considered essential for maintenance of mind-wandering.

In the “control failures x current concerns” view, the contents of mind-wandering are automatically and continuously generated unconsciously in response to environmental cues to subjects' current concerns and goals. Thus, mind-wandering occurs when the primary goal-maintenance process is disrupted, reducing the ability to attend to the task at hand. This hypothesis is supported by evidence that mind-wandering predicts performance deficits on attention-demanding tasks, which may indicate that off-task thoughts enter the mind when control falters, rather than when there is excess capacity (McVay & Kane, 2009; McVay, Kane,

& Kwapil, 2009). Additionally, impairment of cognitive control is related to contexts that increase mind-wandering, such as fatigue (McVay & Kane, 2009; Smallwood et al., 2004; Smallwood, O'Connor, & Heim, 2005; Teasdale et al., 1995) and inebriation (Finnigan, Schulze, & Smallwood, 2007; Sayette, Reichle, & Schooler, 2009). Individual differences in cognitive control have also been negatively associated with mind-wandering during demanding tasks (McVay & Kane, 2009, 2012a, 2012b).

This hypothesis suggests that mind-wandering is a resting state and results from a lack of executive control over this state. Thus, it should be more common in individuals with low WMC (McVay & Kane, 2010), which would include older adults. This is supported by findings that tasks imposing greater cognitive loads reduce mind-wandering in younger adults (Antrobus, 1968; Teasdale et al., 1995, 1993). There is also one study that suggests individual differences in control capacity may be positively associated with mind-wandering during very simple tasks (e.g. breath monitoring), which may indicate individuals with more available cognitive resources use them to mind wander (Levinson, Smallwood, & Davidson, 2012). Older adults have fewer attentional resources in total (Craig & Salthouse, 2008), so engaging in a primary task would greatly reduce the amount of resources available to devote to mind-wandering processes. Indeed, a recent meta-analysis of 49 studies found that individuals with lower cognitive resources tended to engage in more mind-wandering, and individuals with more cognitive resources tended to have on-task thoughts more often (Randall et al., 2014). However, it is also important to note not just amount of thoughts generated, but also the category of the thoughts involved. Older adults may have fewer concerns about personal goals and worries (task-unrelated thought; TUT) and this may lead to less mind-wandering (Giambra, 1989). Of note, there is evidence that older adults report more thoughts about their performance (task-related interference; TRI) than young

adults, yet still report fewer mind-wandering episodes overall (McVay, Meier, Touron, & Kane, 2013). Evidence for these two theories is mixed, and there is presently not enough evidence to fully support either claim. The current study does not aim to support either one of these claims specifically, but rather to elucidate the underlying cognitive processes that cause this age-related decline in mind-wandering.

The content of mind-wandering thoughts has been a recent topic of interest for researchers, as it may hold value when determining the underlying cognitive and neural mechanisms. Within mind-wandering, one distinction of interest is between two categories of off-task thought: task-unrelated thought (TUT) and task-related interference (TRI). Current perspectives on task focus suggest that attention can be directed to one of three places during a task: 1) completion of the task, 2) task-irrelevant information (TUT) or 3) appraisal of the task (TRI) (Smallwood, Obonsawin, & Heim, 2003). TUT is characterized by ideation that is completely unrelated to the task at hand, including upcoming or past events, personal concerns or worries, internally generated stimuli, and daydreams (Smallwood, Obonsawin, et al., 2003). TRI can be defined as preoccupation with performance on the current task, which could be positive or negative in valence. Experimental evidence suggests that the report of TRI is positively correlated with measures of intrusive thinking, while the report of on-task thought is negatively correlated with the same measures, validating this distinction (Smallwood, Obonsawin, Heim, & Reid, 2002).

McVay and Kane (2010) revealed that TRI may be experienced more frequently in older adults due to excessive thoughts about performance and judgmental comparisons between their function and the function of younger individuals as a consequence of fears and biases associated with cognitive aging. This set of distinctions may affect the amount of on-task thoughts recorded

in older adults. Giambra's (1989, 1993) laboratory studies of the relationship between aging and mind-wandering did not consider TRI when probing older adults' thoughts. This was hypothesized to lead to an inflation of on-task thoughts that should actually have been considered TRI. Only recently has a study examined the implications of this distinction in an older adult population. McVay et al. (2013) examined this in a study which allowed the reporting of both TUT and TRI. Older adults reported more TRI than younger adults on several experiment types (SART, 1- and 2-back tests). Across experiments, older adults' reduced TUT rates were not related to performance in comparison to young adults. Additionally, although older adults consistently reported more TRI and less mind-wandering than did younger adults, overall they reported more on-task thoughts. Thus, TRI cannot account completely for prior reports of decreasing TUTs with age. These unexpected results pose some interesting questions about the underlying cognitive mechanisms of mind-wandering and how these processes are initiated. However, this first look at TRI in older adults needs further validation before a definitive conclusion can be drawn about rates of TUT as compared to TRI and on-task thoughts. Further research should be conducted exploring how cognitive control processes, thought focus, and aging relate to one another, specifically in the context of different classifications of mind-wandering.

Mindfulness and Cognitive Control

One factor that may contribute to the reduction of mind-wandering and greater task engagement is mindfulness. Conceptually antagonistic to mind-wandering, mindfulness is characterized by a purposeful, non-judgmental manner of paying attention and relating to the

mind, body and immediate experience (Kabat-Zinn, 2003). To be mindful, individuals must be firmly attentive to the here and now, as opposed to being preoccupied with thoughts about the past or the future (Brown & Ryan, 2003). This present-moment awareness is directed to both internal and external stimuli. Thus, conceptually, the construct of mindfulness is related to attention, and could be theoretically useful to improving engagement in the task at hand.

Although a variety of meditation practices support the cultivation of the principles of mindfulness, focused attention and open monitoring are considered to be at the heart of most traditional mindfulness programs (Lutz, Dunne, & Davidson, 2007). Active mindfulness training entails the practice of self-regulating one's attention and orienting oneself towards the present experience (Davidson et al., 2003; Grossman, Niemann, Schmidt, & Walach, 2004).

Alternatively, the construct of dispositional mindfulness may be conceptualized as an individual's inherent ability to focus on experiences of the present-moment (Brown & Ryan, 2003; Kabat-Zinn, 2003). Additionally, mindfulness may be measured at the state level, capturing the degree to which an individual is oriented to the present moment at a particular time (Tanay & Bernstein, 2013).

Both mindfulness training and dispositional measures of mindfulness have been associated with many indices of mental health, including fewer symptoms of anxiety and depression (Brown & Ryan, 2003; Rasmussen & Pidgeon, 2011; Salmoirago-Blotcher, Crawford, Carmody, Rosenthal, & Ockene, 2011), lower levels of negative affect and self-consciousness (Brown & Ryan, 2003; Evans, Baer, & Segerstrom, 2009) and even increased well-being and perceived health (Bränström, Duncan, & Moskowitz, 2011) in a variety of populations. Recent evidence has provided support for the idea that mindfulness may also improve facets of cognitive control.

Practicing mindfulness has been shown to be beneficial for several aspects of cognition. Mindfulness training has been associated with improvements in a variety of attentional abilities, including selective and sustained attention (Chiesa, Calati, & Serretti, 2011; Tang et al., 2007), attention orienting (Jha, Krompinger, & Baime, 2007) and even working memory capacity (Chambers, Chuen Yee Lo, & Allen, 2008; Jha, Stanley, Kiyonaga, Wong, & Gelfand, 2010; Zeidan, Johnson, Diamond, David, & Goolkasian, 2010). However, some studies have found null results (N. D. Anderson, Lau, Segal, & Bishop, 2007; Moynihan et al., 2013). These mixed results have led to the examination of cognitive effects in conjunction with individual differences of dispositional mindfulness.

Dispositional mindfulness has been found to be related to several aspects of attention and memory. For example, higher dispositional mindfulness is associated with better performance on tasks of sustained attention (SART: Mrazek et al., 2012). An alternate version of the Mindful Attention and Awareness Scale (MAAS) focusing on lapses in attention, was found to be associated with performance detriments on the SART (Cheyne, Carriere, & Smilek, 2006). Additionally, higher dispositional mindfulness has been related to higher inhibitory control in adolescences, even when controlling for cortisol levels—a common stress marker (Oberle, Schonert-Reichl, Lawlor, & Thomson, 2012).

However not all of these results show a clear picture, especially when an older population is examined. In another study that examined dispositional mindfulness, emotion regulation and cognitive performance in both younger and older adults, no significant associations between dispositional mindfulness and cognitive control were found (Prakash, Hussain, & Schirda, 2015). Specifically, scores on the MAAS were not related to performance on computerized measures of working memory, inhibitory control or set-shifting. The authors note that their results may be

due in part to a speed-accuracy trade off that occurs in older adults, however, evidence for this was only found in one task (N-Back). The implications of this finding need to be elucidated further in order to understand the relationship between cognition and mindfulness in older adults.

With the growing literature revealing opposing cognitive outcomes between mindfulness and mind-wandering, several studies have begun to study their relationship experimentally. Mrazek et al. found that just eight minutes of mindful breathing reduced behavioral measures of self-caught mind-wandering, as compared to both passive relaxation and reading (Mrazek et al., 2012). In a second study, they used a 2-week intervention of mindfulness training in undergraduates. They found that, post intervention, self-reported mind-wandering was reduced and performance on both a GRE reading comprehension task and the operation span task (OSPAN) improved, as compared to the scores of those in a nutrition training control (Mrazek, Franklin, Phillips, Baird, & Schooler, 2013). Interestingly, reduction in mind-wandering mediated the impact of mindfulness training on working memory and reading comprehension within this sample.

Pilot data from our laboratory investigated age-related differences in the associations between dispositional mindfulness, indices of MW, and behavioral performance on a task of sustained attention. Older, but not young, adults showed an inverse relation between dispositional mindfulness and self-reported mind-wandering episodes. Mind-wandering, but not dispositional mindfulness, was associated with behavioral performance for both young and older adults. This was the first data to examine both trait mindfulness and mind-wandering in an older adult population, however more information is needed to fully understand the relationships between mindfulness, mind-wandering and cognition.

Current Study

Extending our previous research, the current study aims to elucidate the association between mindfulness and mind-wandering across two cognitive tasks in an older adult population. We hypothesized that higher levels of dispositional mindfulness would be associated with lower levels of off-task thoughts. We also expected that higher proportion of mind-wandering would be associated with lower task accuracy and increased variability of reaction time across both tasks. Additionally, we hypothesized that the proportion of off-task thought would be associated with greater deficits in proactive control, but a greater reliance on reactive control during the CPT-WORD. Additionally, we expected that dispositional mindfulness would be positively associated with task accuracy and negatively associated with variability of reaction time across two cognitive tasks—the Sustained Attention to Response Task (SART) and the Continuous Performance Task, Word Version (CPT-WORD). The use of the CPT-WORD allows us to additionally explore examine how the proactive to reactive shift is associated with mind-wandering in an older adult sample. Lastly, we hypothesized that higher levels of mindfulness would be associated with greater proactive and reactive control abilities. These results will contribute to the understanding of functional health and wellbeing of older adults. Potentially, they would provide support for a novel intervention to improve cognitive function for the elderly. This may improve their daily life by increasing performance on everyday tasks that require cognitive control, like decision making and reading comprehension (Smallwood et al., 2013).

Methods

Participant Characteristics

The sample was drawn from a larger study that investigated the effects of a four-week mindfulness intervention on cognitive performance and mind-wandering. Recruitment tools consisted of newspaper and newsletter advertisements, flyers posted around the community, online resources, and presentations given at senior centers. Terms like “mindfulness” and “meditation” were avoided to minimize participant bias. Volunteers interested in participating underwent a brief telephone interview to partially determine eligibility. Complete eligibility was determined at the first assessment session.

Inclusionary criteria included falling between the ages of 60-74 years; being a native English speaker; being right handed; having no significant mindfulness, meditation or yoga experience; incorrectly answering 2 or less questions on the Ishihara’s Tests for Colour Deficiency Concise Edition (Ishihara, 2010); a score >23 on the Mini-Mental Status Examination (MMSE; maximum score = 30; Folstein, Folstein, & McHugh, 1975); a score of <10 on the Geriatric Depression Scale (GDS; maximum score = 30; Yesavage et al., 1982); corrected near and far acuity of 20/40 or better; no history of diagnosed psychiatric or neurological disorders; no use of psychotropic medication; no use of radiation therapy. All participants provided written informed consent before participating.

For the current study, we will examine baseline cross-sectional data. A total of 74 older adults (mean age = 66.28 years, 58% female, mean education = 16.59 years) met criteria and participated in the study. Table 1 presents demographics of the study participants. Table 2 presents sample characteristics of the study participants. With approval from The Ohio State

University Institutional Review Board, this study took place at The Clinical Neuroscience Laboratory and Psychological Services Center in The Ohio State University Department of Psychology.

Questionnaire

Mindful Attention and Awareness Scale. The Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003) was administered to participants in order to assess trait levels of mindfulness. The MAAS consists of a 15-item self-report questionnaire scored on a 6-point Likert scale from 1 (Almost Always) to 6 (Almost Never), which assesses the experience of mindfulness in a general, everyday context. Mindfulness is measured on the basis of attention to and awareness of thoughts, emotions, and actions. A reverse-scored example statement is, “I rush through activities without really being attentive to them.” Higher scores on the MAAS reflect higher levels of mindfulness disposition. The MAAS has been shown to have good reliability and validity (Brown & Ryan, 2003), as well as having been used in a variety of populations such as in adolescents, cancer patients, and healthy adults, including older adult populations (Brown, West, Loverich, & Biegel, 2011; Carlson & Brown, 2005; MacKillop & Anderson, 2007; Morone, Rollman, Moore, Li, & Weiner, 2009).

Cronbach’s $\alpha = .760$. Appendix 2 contains the full version of the MAAS.

Cognitive Measures

Each participant completed two widely used measures of cognitive control: the Go/No-Go Task (Logan, Cowan, & Davis, 1984) and the Continuous Performance Task (Beck, Bransome,

Mirsky, Rosvold, & Sarason, 1956). Mind-wandering probes (discussed below) were presented within both of these measures.

Go/No-Go Task. In the Go/No-Go task, participants were asked to respond to frequent non-targets (Go trials) by pressing the key corresponding with the presented character and to inhibit their responses if preceded by a tone (No-Go trials). The use of either “Z” and “/” or “X” and “M” as stimuli was counterbalanced across participants. Participants first completed a practice block of Go without any No-Go trials. Following the first practice block, participants were instructed via computer prompt to respond to the stimuli except for when they heard a tone. Practice trials were then conducted practicing the No-Go response. This was followed by 6 blocks consisting of 63 trials, of which 54 were Go trials, 6 were No-Go trials and 3 were probe trials. The number of No-Go trials and Go trials were counterbalanced across blocks. Each trial began with a fixation cross for 749 ms followed by the stimulus for 749 ms. Responses within 1500 ms were recorded. The entire task duration lasted approximately 35 minutes. Figure 1 illustrates the schematic of the Go/No-Go Task.

For each participant, we acquired response time data on the Go trials, as well as the number of correct responses, misses (errors of omission) and false alarms (errors of commission). We calculated coefficient of variability for reaction times by dividing the standard deviation of the RT on Go trials by the mean RT on Go trials ($RT_CV = RT (SD)/RT (Mean)$). A higher coefficient of variability in the context of the Go/No-Go Task is reflective of greater fluctuation of response time data throughout the course of the task. Additionally, we calculated signal-detection sensitivity scores (d_L) that take both correct responses on the Go trials (Hits) and incorrect responses on the No-Go trials (False Alarms) into account. This was calculated using

the formula for logistic distributions, $dL = \ln\{[H(1-FA)]/[(1-H)FA]\}$, with Go trial accuracy and No-Go trial errors adjusted by 0.001. Table 4 illustrates all correlations completed with the Go/No-Go task.

Continuous Performance Task–WORD version (CPT-WORD). The Continuous Performance Task (Beck et al., 1956) is an assessment of conditional target-nontarget discrimination ability and the ability to sustain effort in a cognitively demanding situation. Additionally, this task is widely used in the discrimination of proactive and reactive control (Braver, 2012; Braver et al., 2007). For this study, we used a slightly modified version of this task that uses words instead of letters, the CPT-WORD, which has been validated in an older adult population (Paxton, Barch, Racine, & Braver, 2008). In this task, participants were asked to respond with a “Yes” key after seeing a two-word target sequence consisting of a cue followed by a delay and then a probe. They were instructed to press the “No” key for all other stimuli, including the cue, the probe not preceded by the target cue, or any other word. Target “AX” trials (i.e., “A” followed by “X”) occurred with 70.8% frequency and non-target trials occurred with 29.2% frequency. The frequency of each non-target trial type was evenly distributed such that there were 12.5% “BX” trials in which a non-target cue preceded the target probe (i.e., a word other than “A” followed by “X”); 12.5% “AY” trials in which a target cue is followed by a non-target probe (i.e., the word “A” followed by a word other than “X”); and 4.2% “BY” trials in which a non-target cue is followed by a non-target probe (i.e., a word other than “A” was followed by a word other than “X”). All words were drawn from the MRC Psycholinguistic Database: Machine Usable Dictionary Version 2.00 (Wilson, 1988) using several criteria: 3-5

characters in length, 1-2 syllables, nouns, familiarity = 542-544.5, and frequency = 33-36. Word lists used in each version of the task can be seen in table 3.

Words were presented one at a time (750 msec. each) in cue-probe sequences, with a delay in-between. Two delay times were used to manipulate task demand; long-delay (5000 msec.) and short-delay (1000 msec.). There was a jittered inter-trial interval such that the delay between each trial was equal within each block. Short- and long-delay blocks were presented in an alternating sequence (short, long, short, long, etc.), but the order of the starting block was randomly generated. Participants first completed an instruction block of sample trials in which no responses were recorded. Following the instruction block, participants completed both a long-delay and short-delay practice block. This was followed by 8 blocks (4 long-delay, 4 short-delay, alternating between short and long with the first presentation delay counterbalanced) of 24 trials each. Each trial began with the cue for 749 msec. followed by a short or long delay period and then the target was presented for 749 msec. The entire task duration lasted approximately 60 minutes including practice trials. Figure 2 illustrates the schematic of the CPT-WORD task.

For each participant, we acquired response time data for both cues and probes. We calculated coefficient of variability of reaction time by dividing the standard deviation of the RT on both cue and probe trials by the mean RT on cue and probe trials ($RT_CV = RT (SD)/RT (Mean)$). A higher coefficient of variability in the context of the CPT is reflective of greater fluctuation of response time data throughout the course of the task.

We collected data on correct detection, omission errors as well as the three commission error types: non-cue, target; cue, non-target; and non-cue, non-target. These three error types indicate different types of failures of task engagement in regards to proactive and reactive control. We calculated the signal-detection sensitivity score for both proactive ($d_{Lproactive}$) and

reactive ($d_{L\text{reactive}}$) control types using the “BX” and “AY” trial types respectively. Higher $d_{L\text{proactive}}$ and $d_{L\text{reactive}}$ scores relate directly to better proactive and reactive control, respectively, throughout the tasks. These were both calculated using the formula for logistic distributions ($d_L = \ln\{[H(1-FA)]/[(1-H)FA]\}$), where H= correct AX trials, FA= false alarms on BX or AY trial types with H scores adjusted by +0.001 and FA scores adjusted by -0.001. Table 5 illustrates all correlations completed with the CPT-WORD.

Mind Wandering Probes. Mind-wandering probes were presented at quasi-random intervals within each of these tasks in order to assess the frequency of probe-caught mind-wandering. After receiving instructions for responding to thought probes, participants completed practice blocks of the computerized task with embedded probes. Each probe consisted of four questions presented sequentially. The first question aimed to gather a categorical distinction of the participant’s thoughts. Participants were asked to categorize the thoughts they had in the preceding seconds as either on-task (“1” key); evaluating one’s performance (task-related interference, “2” key); or focused on personal worries, everyday things, daydreams, other (task-unrelated thought, “3” key). The second question allowed the participant to record the thought they were experiencing using the keyboard. The third question asked the participant to record the judgmental nature of the thought. Participants rated their thought on a 5-point Likert ranging from not at all judgmental (“1” key) to extremely judgmental (“5” key). The fourth question asked participants to categorize the temporal focus of the thought to past (“1” key), present (“2” key) or future (“3” key). If participants responded to the first question as on-task, they were asked to not respond to the second question and respond 0 to questions 3 and 4. For the purposes of this study, categorical responses of evaluating one’s performance (task-related interference, “2” key);

or focused on personal worries, everyday things, daydreams, other (task-unrelated thought, “3” key) were both considered to be mind-wandering. Figure 3 illustrates the schematic of the probes used in the two tasks.

The use of self-report probes has been used and validated as a way of measuring mind-wandering during several types of tasks including the SART, OSPAN and passage reading (Jackson & Balota, 2012; Mrazek, Franklin, et al., 2013; Mrazek, Phillips, et al., 2013; Smallwood, Beach, Schooler, & Handy, 2007; Smallwood, McSpadden, & Schooler, 2008). Research at the neurological level has found convergence between self-reported mind-wandering and activation of the brain’s typical activation pattern during off-task thought (enhanced activity of the default mode network; Smallwood et al., 2013). Previous probe designs have examined varying methodology to look at various several different types of categorical distinctions (see: Christoff et al., 2009; Smallwood, Baracaia, et al., 2003; Smallwood et al., 2007). Expanding upon previous probe methodology, the probes administered were designed to be minimally disruptive to the task while allowing for insight on the content as well as two facets of mindfulness: judgmental nature, and temporal focus of the participants thoughts throughout the tasks.

Data Analytic Strategy

Data were collected from 74 older adults. Data from one participant was excluded from WORD-CPT analyses due to using the incorrect hand to make responses. The WORD-CPT requires the use of two fingers on one hand and the participant completed the task using their right hand but subsequently reported that they are left-handed rendering their data invalid.

However, since both hands are used with equal frequency in the Go/No-Go task, the data from this participant was included for Go/No-Go analyses. Additionally, one participant was excluded from all Go/No-Go task due to an accuracy score of 0.11. This participant did not have this same performance issue on the CPT-WORD, thus, indicating a misunderstanding of the instructions for the Go/No-Go task. Total scores on the MAAS were used as measures of dispositional mindfulness. For the purposes of these analyses, categorical responses of TRI and TUT were both considered to be mind-wandering, and combined into one variable, off-task thought. The proportion of off-task thought was used as a self-report measure of mind-wandering throughout each task was used as a behavioral measure of mind-wandering. Behavioral performance indices included d_L as a measures of task accuracy on the Go/No-Go Task, $d_{L\text{proactive}}$ and $d_{L\text{reactive}}$ as measures of proactive and reactive control on the CPT-WORD, and RT_CV as a measure of response time variability on both tasks. The main variables of interest, MAAS scores, mind-wandering reports, and measures of performance on the Go/No-Go Task (RT_CV and d_L) and CPT-WORD (RT_CV, $d_{L\text{proactive}}$ and $d_{L\text{reactive}}$) were first tested for outliers. Outliers were defined as any z -score ± 2.5 standard deviations from the mean. Scores exceeding these thresholds were corrected with z -scores equivalent to ± 2.5 standard deviations from the mean. Following this correction procedure, the normality of each variable was checked using the Kolmogorov-Smirnov test.

We examined the following hypotheses within an older adult sample: (1) mindfulness and mind-wandering are negatively associated, (2) mindfulness and indices of task performance are negatively associated, and (3) mind-wandering and indices of task performance are positively associated. Bivariate correlations were conducted on all variables using Spearman's rank-order

correlations with significance based on two-tailed tests. All analyses were performed using SPSS 20.0 (IBM, New York).

Results

Mindfulness Disposition and Mind-Wandering

In order to determine the relationship between dispositional mindfulness and indices of mind-wandering collected during both the Go/No-Go task and CPT-WORD, we conducted bivariate correlations. In support of our hypothesis, dispositional mindfulness was significantly negatively associated with mind-wandering in both the Go/No-Go task ($\rho = -0.316, p = .006$, two-tailed) and CPT-WORD ($\rho = -0.286, p = .014$, two-tailed).

Mind-Wandering and Task Performance

Next, we conducted bivariate correlations to assess the association between mind-wandering and performance indices on both the Go/No-Go task and CPT-WORD. In contrast to our hypotheses, accuracy scores on the Go/No-Go Task were not significantly associated with mind-wandering during the Go/No-Go task ($\rho = -0.152, p = .200$, two-tailed). Proactive and reactive indices were also not significantly associated with mind-wandering in the CPT-WORD ($\rho = 0.044, p = .710$, two-tailed, and $\rho = -0.092, p = .437$, two-tailed, respectively). Partially confirming our hypothesis, mind-wandering was significantly positively associated with variation in reaction time in the Go/No-Go task ($\rho = 0.242, p = .039$, two-tailed) but not the CPT-WORD ($\rho = 0.167, p = .159$, two-tailed).

Mindfulness Disposition and Task Performance

We conducted bivariate correlations to examine the relationship between mindfulness and performance indices on both the Go/No-Go task and CPT-WORD. Contrary to our hypotheses, dispositional mindfulness was not significantly associated with accuracy scores on the Go/No-Go Task ($\rho = 0.166$, $p = .160$, two-tailed). Reactive ($\rho = 0.245$, $p = .037$, two-tailed), but not proactive ($\rho = 0.021$, $p = .863$, two-tailed) control was significantly positively associated with mindfulness disposition on the CPT-WORD. Partially confirming our hypothesis, dispositional mindfulness was not significantly associated with variability in reaction time on the Go/No-Go task ($\rho = -0.158$, $p = .182$, two-tailed) but was associated with variability of reaction time in the CPT-WORD ($\rho = -0.242$, $p = .039$, two-tailed).

Discussion

The purpose of the present study was to investigate the associations between dispositional mindfulness, mind-wandering, and task performance in an older adult sample. Our results give a preliminary look into the relationship between mind-wandering and mindfulness in a sample of older adults. The results of the current study extend the previous literature by showing a negative relationship between dispositional mindfulness and the proportion of mind-wandering in older adults. Contrary to previous findings, the proportion of mind-wandering was not related to task accuracy on the Go/No-Go task or the CPT; however, it was found to be related to variability in reaction time on the Go/No-Go task, but not the CPT. Dispositional mindfulness was not associated with task accuracy or reaction time variability on the Go/No-Go task, but on the CPT-

WORD it was found to be related to both reactive control and reaction time variability, but not proactive control.

Building upon previous literature, our results provide additional evidence that mindfulness and mind-wandering are related, particularly in the context of cognitive tasks. The research surrounding the relationship between mindfulness and mind-wandering is limited, with only four studies looking at the integration of these two concepts directly. Fast and careless response patterns on a sustained attention task was found to be associated with lower self-reported dispositional mindfulness (Cheyne et al., 2006). Additionally, an adapted version of the MAAS, focusing solely on lapses in attention, was associated with several performance markers of mind-wandering on the SART (Cheyne, Solman, Carriere, & Smilek, 2009). Mrazek et al. (2012) found that MAAS scores were negatively associated with behavioral measures of self-caught mind-wandering in a sample of college undergraduate students. They also found that 8 minutes of mindful breathing attenuated indirect performance markers of mind-wandering in a task of sustained attention compared to both passive relaxation and reading interventions. In a second study, they used a 2-week intervention of mindfulness training in an undergraduate sample and found an increase in mindfulness scores and a reduction in self-reported mind-wandering post-intervention (Mrazek, Franklin, et al., 2013). Consistent with previous examinations in young adults, dispositional mindfulness was indeed significantly negatively associated with self-reported mind-wandering in our older adult sample. This was found to be true across two cognitive tasks, suggesting that this association holds across two different task contexts. Specifically, these two tasks are different in terms of what types of cognitive control are required for success; the Go/No-Go primarily requires inhibitory control and the CPT-

WORD primarily requires both sustained attention and top-down control processes. Our results show that this relationship is robust even across varied cognitive processes and task demands.

In contrast with previous findings, mind-wandering was not associated with accuracy in either task. A recent meta-analysis of 88 studies revealed that off-task thought was significantly negatively associated with task performance (Randall et al., 2014). Although this meta-analytic review included studies that employed a wide variety of task types including the SART, the Stroop task, tasks of working-memory, choice reaction time, visual search as well as more ecologically related tasks like reading comprehension and math, all of these studies were conducted with young to middle age adults.

In an older adult population, however, the results become more mixed. Jackson and Balota (2012) found that their results consistently indicated that older adults were at some level performing better than younger adults. That is, accuracy was numerically higher across three SART experiments, and they reported less mind-wandering compared to young adults. The relative difference in age-related reports of mind-wandering occurred even though manipulations of the presentation rate across experiments varied the frequency of mind-wandering probes dramatically. Similarly, Maillet & Rajah (2013) found that a memory encoding task influenced the type of internal thoughts experienced by young, but not older, adults. Secondly, across both tasks they found marked age-related decreases mind-wandering at encoding, and frequency of these thoughts negatively impacted memory retrieval in young adults only. McVay et al. (2013) found that older adults mind-wander less often than younger adults in a 1-back task and that this finding persisted even in the more cognitively-demanding 2-back task in which younger adults outperformed older adults. This finding suggests that mind-wandering frequency may not be a primary cause of age-related declines in performance on executive tasks, which could help

explain the finding in the current study of a null relationship between task performance and mind-wandering.

Taken together these results suggest that the relationship between performance and mind-wandering in an older adult population is more nuanced than in a young adult population, where decreases in mind-wandering are not always directly associated with improved performance. Mind-wandering in older adults is stable across different task complexities, and is seen in both demanding and non-demanding tasks. Additionally, there is support for the TUT-TRI distinction effecting behavioral performance. McVay and colleagues (2013) outlined very distinct findings when mind-wandering was separated into task-unrelated thought (TUT) and task-related interference (TRI). Specifically, TUT was negatively associated with accuracy in both older adults and younger adults and TUT was not differentially costly for older adults as compared to young adults. Interestingly, TRI was only associated with performance errors in the more difficult tasks – standard SART and 2-back, but not vigilance SART or 1-back. Finally, age differences in TRI were in the opposite direction to those in TUTs, with older adults reporting more TRI experiences but fewer TUTs. These results suggest that there may be a differential relationship between TUT and performance and TRI and performance in older adults.

There are several methodological differences that may account for the discrepancies between our results and previous findings. First, our analyses combined both TUT and TRI into mind-wandering category. If there are differential relationships between TUT, TRI, and performance, the current approach may overlook these, contributing to the observed null associations. Future analyses will be conducted to parse the differential contributions of these two task-unrelated thoughts on behavioral performance. Additionally, in our study an experimenter was present in the room at all times while the participant was completing the tasks,

which is very different from the cubical-style group setting used by McVay et al. (2013). This may have led to changes in demand characteristics experienced by the participants, as older adults have been shown to experience contextually primed concerns about intellectual aging (Sindi et al., 2011). Task length was also a factor that could have impacted the relationship between mind-wandering and performance. In our study, tasks were significantly longer (35-60 minutes in length) than those used by McVay et al. (2013) (20 minutes in length). This length may have led to practice effects, which may be represented in the overall high accuracy scores. Well-practiced tasks become easier to perform because task-relevant information becomes represented at an increasingly abstract level (J. R. Anderson, 2013; Smallwood & Schooler, 2006). As participants become skilled, fewer decisions are made consciously. Put simply, practice decreases the need for executive control in performing a task. This would lead, theoretically, to an increase in mind-wandering as more attentional resources are available for use. Indeed, an increase in mind wandering in well-practiced situations has been observed using both self-caught and probe-caught methods (Giambra, 1995; Smallwood, Baracaia, et al., 2003). Thus, given the length of the task, participants may have shown improvements in task performance due to practice effects as well as increases in mind-wandering due to a decreased need for cognitive resources which may have weakened the association between the two. Additionally, variables such as increased fatigue (McVay & Kane, 2009; Smallwood et al., 2007) and decreased task engagement might also compromise this relationship. Further analysis would be needed to identify which, if any, of these processes were at play in the current study.

The lack of association between mind-wandering and task accuracy in our data may also be attributed in part to the observed ceiling effects within the tasks. For example, in the studies by Teasdale et al. (1993) participants performed at high levels of accuracy (96%–100%), and the

authors concluded that mind-wandering was not associated with poor performance. Data from the Go/No-Go Task yielded high accuracy scores on both Go (Mean = 0.973, SD = 0.027, range = 0.836-1.00) and No-Go stimuli (Mean = 0.892, SD = 0.080, range = 0.665-0.999). There were also high accuracy scores seen across different trial types of the CPT-WORD: AX (Mean = 0.975, SD = 0.031, Ranged from 0.808-1.00-), BX (Mean = 0.950, SD = 0.055 Ranged from 0.791-1.00), and AY (Mean = 0.952, SD = 0.0521, Ranged from 0.770-1.00) trials. High accuracy scores and relatively small standard deviations on these tasks suggest that there was low variance in performance, thus leading to a restricted range that could contribute to null relationships between these variables and mind-wandering. It should also be noted that in our calculations of accuracy scores, we have collapsed across both task load manipulations (short-delay and long-delay on the CPT-WORD) and trial types (AX, AY, BX, BY), which may also obscure the more detailed relationships between performance and mind-wandering.

Although mind-wandering was not related to accuracy, it was positively associated with reaction time variability on the Go/No-Go Task, but not the CPT task. This means that mind-wandering was associated with the ability to react consistently to stimuli over time within the Go/No-Go Task. Past literature has indicated that variability in reaction time is an important indicator of cognitive function as well as aging (Hultsch, MacDonald, & Dixon, 2002). Response time variability is thought to partially reflect degradations in age-related frontal lobe integrity (MacDonald, Nyberg, & Bäckman, 2006) and broader task positive cognitive functions (Kelly, Uddin, Biswal, Castellanos, & Milham, 2008) such as attention allocation and cognitive control (West, Murphy, Armilio, Craik, & Stuss, 2002). Thus, reaction time variability can be conceptualized as a precursor to detriments in accuracy, as a measure of task engagement. Our results suggest, in part, that mind-wandering was in fact related to less consistent response

patterns within the Go/No-Go task, possibly representing less engagement. Still, this lack of engagement may not be indicative of a cost-prohibitive nature, specifically on a straightforward task such as the Go/No-Go task due to the relatively low cognitive demands of the task.

There is considerable support for improvements in cognitive control following mindfulness training from randomized controlled trials (Chiesa et al., 2011; Jha et al., 2007; Mrazek, Franklin, et al., 2013; Tang et al., 2007), although some studies have produced null findings (N. D. Anderson et al., 2007; MacCoon, MacLean, Davidson, Saron, & Lutz, 2014). However, cross-sectional examinations of the relationship between dispositional mindfulness and cognition are limited and have produced mixed findings. Oberle et al. (2012) found that higher MAAS scores significantly predicted greater percent accuracy in a test of inhibitory control in a sample of early adolescents, which was true even when gender, grade, and cortisol levels were controlled for. Additionally, mindfulness disposition was found to be associated with cognitive control during tasks of working-memory and inhibitory control in an undergraduate sample (Anicha, Ode, Moeller, & Robinson, 2012). However, both of these studies were done in samples of young adults or children, which are very different developmentally and cognitively from older adults. In another study that examined both younger and older adults, no significant associations between dispositional mindfulness and cognitive control were found (Prakash et al., 2015).

Our study is the first to examine the association between dispositional mindfulness, mind-wandering and cognitive control in an older adult cohort. Surprisingly, we found that mindfulness and accuracy on the Go/No-Go Task were not significantly associated. However, in our examination of the CPT-WORD, mindfulness was found to be related to reactive but not proactive control. Mindfulness may be more robustly related to reactive control in our sample since reactive control is better preserved than proactive control in older adults (Bugg, 2014).

Additionally, the task demand as well as resources required to use different strategy types may both play important roles in which control strategies are used by older adults. Proactive control is associated with a continued activation of the prefrontal cortex, which requires a large amount of cognitive resources to maintain; whereas reactive strategies, on the other hand, are accompanied by intermittent activation of the prefrontal cortex (Braver, 2012). If task demands are low enough, individuals can use reactive control to reach similar levels of accuracy without engaging in the more resource-demanding proactive control strategy. The strategy used may also depend on engagement and desire to complete the task correctly. Therefore, our results provide preliminary insight into how mindfulness is related to the proactive-reactive shift that occurs in the aging brain. Individuals who reported being more mindful showed more reactive control abilities. Given that as we age we employ reactive strategies more frequently (Braver, 2012; Braver & Barch, 2002), our results indicate that individuals with higher levels of mindfulness may be better able to employ reactive strategies.

Additionally, dispositional mindfulness was not significantly related to reaction time variability on the CPT-WORD task or Go/No-Go task. However, reaction time variability alone is not specific enough to examine the differences in reactive versus proactive control use. More nuanced analyses are needed to build further on this distinction.

There are several limitations to our study, which should be taken into consideration when interpreting the results. The cross-sectional nature of this study is inherently limiting to the strength of the results. A full examination of mechanisms of mindfulness, mind-wandering, cognitive control and age would involve a randomized control design with an intervention of mindfulness training. Secondly, the high accuracy on both of our tasks may have limited the degree of variance within our data, which subsequently may have impacted our findings.

In summary, our results provide preliminary evidence for an association between mindfulness and mind-wandering in an older adult sample. Contrary to our hypothesis, we did not find an association between mind-wandering and task accuracy on either task; however, we did find an association between MW and variability of reaction time on the Go/No-Go task. Additionally, we found an association between mindfulness and reactive control on the CPT-WORD. Future studies should continue to examine the relationships between mindfulness, mind-wandering and cognitive control strategies, parceling apart more specifically how mindfulness is related to mind-wandering across varied task contexts. The use of neuroimaging to elucidate the neural mechanisms of such processes in older adults would be beneficial to understanding the currently understudied relationship between mindfulness and the aging brain.

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Table 1.

Study Sample Demographics For Total Sample of 74 Older Adults

Demographic	Mean (SD)
Age	66.29 (3.926)
Education	16.59 (2.711)
Gender	Number (%)
Female	43 (58.1%)
Male	31 (41.9%)

Table 2.
Study Sample Characteristics of Older Adult Participants

Measure	Category	Mean (SD)
MAAS	---	4.44 (0.610)
Go/No-Go*	Proportion MW	0.34 (0.278)
	d _L	6.70 (2.247)
	RT_CV	0.20 (0.040)
CPT-WORD**	Proportion MW	0.24 (0.215)
	Proactive d _L	7.90 (3.039)
	Reactive d _L	7.83 (2.834)
	RT CV	0.26 (0.052)

Note. *N*=74 Data listed in the table represent raw scores prior to transformation. * *N*=73 for all Go/No-Go data due to one exclusion. ** *N*=73 for all CPT-WORD data due to one exclusion.

Table 3.

List of words used in each version of the Continuous Performance Test, Word Version

	Version 1		Version 2	
	Cue	Probe	Cue	Probe
Target	MYTH	TAPE	YARD	DRILL
Non Target	BENCH	GRADE	ROLL	FISH
	WASTE	KNEE	CORN	CRIME
	BONE	RICE	ALERT	BONE
	SMELL	FATE	GUIDE	GIFT
	OWNER	GOLF	CASH	FRUIT

Table 4.

Spearman's Correlations Between Mindfulness Disposition, Mind-Wandering and Task Performance in Older Adults on the Go/No-Go Task.

	1	2	3	4
1. MAAS	1	-.316**	.166	-.158
2. Proportion MW		1	-.152	.242*
3. d_L			1	-.498**
4. RT_CV				1

Note. $N=73$. Higher numbers reflect higher (1)MAAS, (2) higher proportion MW, (3) higher d_L, and (4) larger RT_CV. * $p \leq .05$, ** $p \leq .01$

Table 5.

Spearman's Correlations Between Mindfulness Disposition, Mind-Wandering and Task Performance in Older Adults on the CPT-WORD Task.

	1	2	3	4	5
1. MAAS	1	-.286*	.021	.245*	-.143 ^a
2. Proportion MW		1	.044	-.092	.159
3. d_{Lproactive}			1	.354**	-.124
4. d_{Lreactive}				1	-.256*
5. RT_CV					1

Note. $N=73$. ^a denotes Pearson's correlation. Higher numbers reflect higher (1) MAAS, (2) higher proportion MW, (3) higher d_{Lproactive}, and d_{Lreactive} and (4) larger RT_CV. * $p < .05$, ** $p < .01$

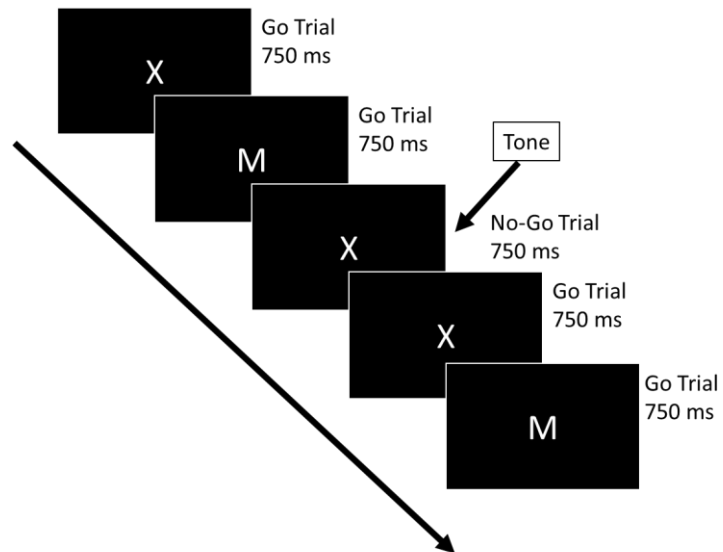
Go/No-Go Task flowchart

Figure 1. A schematic representation of the Go/No-Go Task. Participants were asked to respond to the letter on the screen but withhold their response when a tone was present.

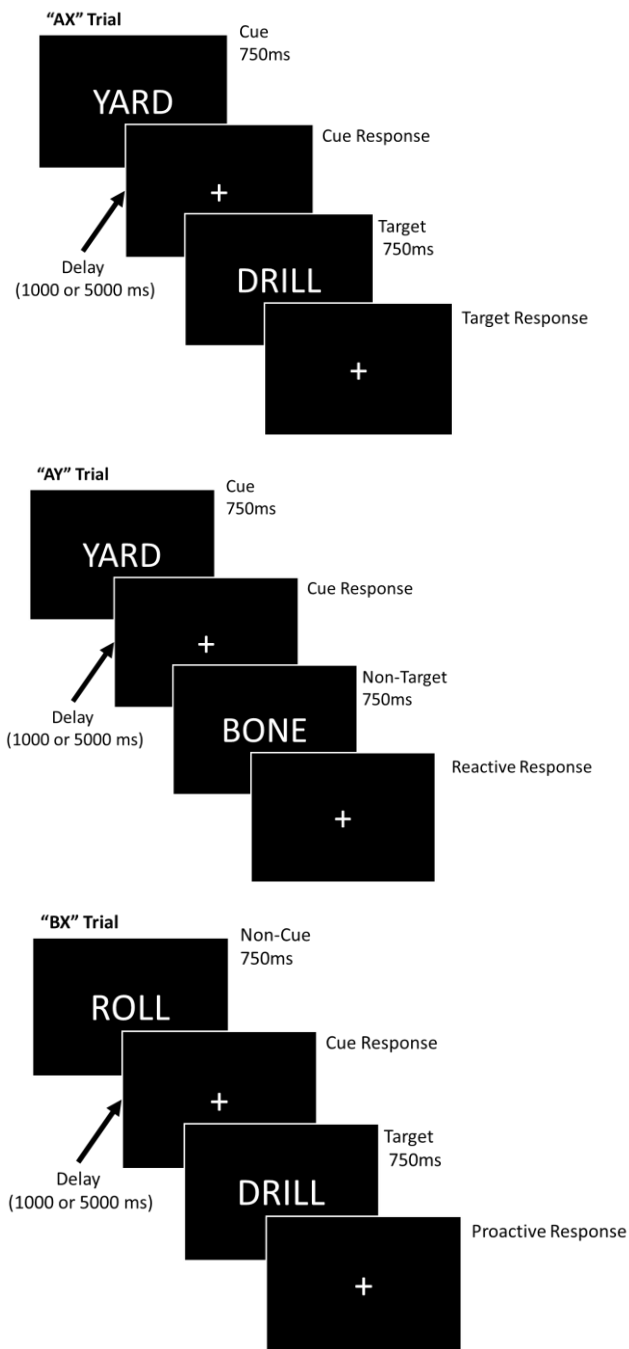
CPT-WORD flowchart

Figure 2. A schematic representation of the CPT-WORD. Participants were asked to respond "yes" after seeing a complete target sequence ("AX" trial) and "no" to all other stimuli. "AY" and "BX" trial types were used to measure reactive and proactive control abilities, respectively.

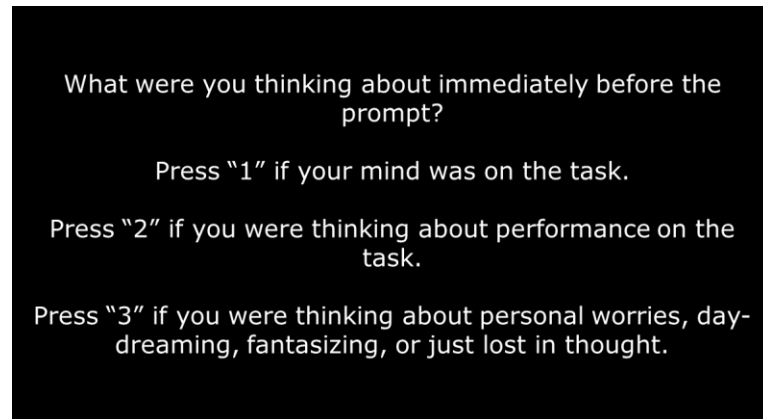
Probe Prompt

Figure 3. A representation of the first question of the mind-wandering probes embedded in each task.

Appendix 1.

Mindfulness Attention Awareness Scale (MAAS)

Below is a collection of statements about your everyday experiences. Using the 1-6 scale below, please indicate how frequently or infrequently you have each experience. Please answer according to what really reflects your experience rather than what you think your experience should be.

1-----2-----3-----4-----5-----6
 Almost Always Almost Never

- _____ 1. I could be experiencing some emotion, and not be conscious of it until some time later.
- _____ 2. I break or spill things because of carelessness, not paying attention, or thinking of something else.
- _____ 3. I find it difficult to stay focused on what's happening in the present.
- _____ 4. I tend to walk quickly to get where I'm going without paying attention to what I experience along the way.
- _____ 5. I tend not to notice feelings of tension or physical discomfort until they really grab my attention.
- _____ 6. I forget a person's name almost as soon as I've been told it for the first time.
- _____ 7. It seems I am "running on automatic" without much awareness of what I'm doing.
- _____ 8. I rush through activities without being really attentive to them.
- _____ 9. I get so focused on the goal I want to achieve that I lose touch with what I'm doing right now to get there.
- _____ 10. I do jobs or tasks automatically, without being aware of what I am doing.
- _____ 11. I find myself listening to someone with one ear, doing something else at the same time.
- _____ 12. I drive places on "automatic pilot" and then wonder why I went there.
- _____ 13. I find myself preoccupied with the future or the past.
- _____ 14. I find myself doing things without paying attention.
- _____ 15. I snack without being aware that I am eating.